

CLAIMS

What is claimed is:

- 1 1. A method for symbol synchronization comprising:  
2 performing a windowing function on a received signal  
3 to produce a symbol sample;  
4 multiplying the symbol sample and a reference  
5 synchronization symbol in the frequency domain to produce  
6 a first signal;  
7 determining the sign of the first signal to produce a  
8 second signal; and  
9 performing a Fourier transform on the second signal  
10 to produce a third signal containing time-shift  
11 information to align the received signal.
- 1 2. The method of claim 1 wherein the length of the  
2 symbol sample is equal to the length of the reference  
3 synchronization symbol.
- 1 3. The method of claim 1 wherein the windowing function  
2 is accomplished by a Hanning windowing function.
- 1 4. The method of claim 1 further comprising:  
2 performing a Fourier transform on the symbol sample  
3 to transform the symbol sample from the time domain to the  
4 frequency domain before it is multiplied with the  
5 reference synchronization symbol.
- 1 5. The method of claim 1 wherein the first signal  
2 comprises real and imaginary frequency components.  
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1 6. The method of claim 5 wherein determining the sign of  
2 the first signal comprises determining the signs of both  
3 the real and imaginary frequency components of the first  
4 signal to produce two corresponding signal components  
5 which comprise a fourth signal.

1 7. The method of claim 6 wherein the two components of  
2 the fourth signal are convolved to produce the second  
3 signal.

1 8. The method of claim 1 wherein the Fourier transform  
2 performed on the second signal is a fast Fourier  
3 transform.

1 9. The method of claim 1 wherein the third signal  
2 comprises real and imaginary components.

1 10. The method of claim 9 further comprising:  
2 adding the real and imaginary components of the third  
3 signal together to produce a fifth signal.

1 11. The method of claim 10 further comprising:  
2 aligning the received signal according to the time-  
3 shift indicated by the fifth signal.

1 12. The method of claim 10 further comprising:  
2 detecting the peak of the fifth signal to determine  
3 the time-shift required to align the received signal.

1 13. The method of claim 12 further comprising:

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2       generating an index based on the location of the  
3 detected peak, the index corresponding to the amount by  
4 which to time-shift the received signal to synchronize it.

1   14. The method of claim 12 wherein the magnitude of the  
2 peak indicates the direction of the time-shift required to  
3 align the received signal.

1   15. A machine-readable medium having one or more  
2 instructions for synchronizing a received signal, which  
3 when executed by a processor, causes the processor to  
4 perform operations comprising:  
5       performing a windowing function on the received  
6 signal to produce a symbol sample;  
7       multiplying the symbol sample and a reference  
8 synchronization symbol in the frequency domain to produce  
9 a first signal;  
10       determining the sign of the first signal to produce a  
11 second signal; and  
12       performing a Fourier transform on the second signal  
13 to produce a third signal containing time-shift  
14 information to align the received signal.

1   16. The machine-readable medium of claim 15 wherein the  
2 length of the symbol sample is equal to the length of the  
3 reference synchronization symbol.

1   17. The machine-readable medium of claim 15 wherein the  
2 windowing is accomplished by a Hanning windowing function.

1 18. The machine-readable medium of claim 15 further  
2 comprising:  
3 performing a Fourier transform on the symbol sample  
4 to transform the symbol sample from the time domain to the  
5 frequency domain before it is multiplied with the  
6 reference synchronization symbol.

1 19. The machine-readable medium of claim 15 wherein the  
2 first signal comprises real and imaginary frequency  
3 components.  
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1 20. The machine-readable medium of claim 19 wherein  
2 determining the sign of the first signal comprises  
3 determining the signs of both the real and imaginary  
4 frequency components of the first signal to produce two  
5 corresponding components which comprise a fourth signal.

1 21. The machine-readable medium of claim 20 wherein the  
2 two components of the fourth signal are convolved to  
3 produce the second signal.

1 22. The machine-readable medium of claim 15 wherein the  
2 Fourier transform performed on the second signal is a fast  
3 Fourier transform.

1 23. The machine-readable medium of claim 15 wherein the  
2 third signal comprises real and imaginary components.

1 24. The machine-readable medium of claim 23 further  
2 comprising:

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3 adding the real and imaginary components of the third  
4 signal together to produce a fifth signal.

1 25. The machine-readable medium of claim 24 further  
2 comprising:

3 aligning the received signal according to the time-  
4 shift indicated by the fifth signal.

1 26. The machine-readable medium of claim 25 further  
2 comprising:

3 detecting the peak of the fifth signal to determine  
4 the time-shift required to align the received signal.

1 27. The machine-readable medium of claim 26 further  
2 comprising:

3 generating an index based on the location of the  
4 detected peak, the index corresponding to the amount by  
5 which to time-shift the received signal to synchronize it.

1 28. The machine-readable medium of claim 26 wherein the  
2 magnitude of the peak indicates the direction of the time-  
3 shift required to align the received signal.

1 29. A device for aligning a received signal comprising:  
2 a windowing module to perform a windowing function on  
3 the received signal to produce a symbol sample therefrom;  
4 a multiply module communicatively coupled to the  
5 windowing module to receive the symbol sample and multiply  
6 the symbol sample to a reference synchronization symbol in  
7 the frequency domain to produce a first signal therefrom;

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8 a sign detector module communicatively coupled to the  
9 multiply module to receive the first signal, determine the  
10 sign of the first signal, and produce a second signal  
11 therefrom; and

12 a Fourier transform module communicatively coupled to  
13 the sign detector module to receive the second signal,  
14 perform a Fourier transform on the second signal, and  
15 produce a third signal therefrom containing time-shift  
16 information to align the received signal.

1 30. The device of claim 29 wherein the length of the  
2 symbol sample is equal to the length of the reference  
3 synchronization symbol.

1 31. The device of claim 30 wherein the windowing module  
2 is capable of performing a Hanning windowing function.

1 32. The device of claim 29 wherein the first signal  
2 produced by the multiply module has real and imaginary  
3 components.

1 33. The device of claim 32 wherein the sign detector  
2 module determines the sign of the real and imaginary  
3 components of the first signal, and produces two  
4 corresponding signal components which comprise a fourth  
5 signal.

1 34. The device of claim 33 further comprising:  
2 a convolution module communicatively coupled to the  
3 sign detector module to receive the fourth signal

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4 components and convolved them to produce the second  
5 signal.

1 35. The device of claim 29 wherein the Fourier transform  
2 module is capable of performing fast Fourier transforms.

1 36. The device of claim 29 further comprising:  
2 a second Fourier transform module communicatively  
3 coupled to receive the second signal from the sign  
4 extractor module, perform a Fourier transform on the  
5 symbol sample to transform the symbol sample from the time  
6 domain to the frequency domain before it is multiplied to  
7 the reference synchronization symbol.

1 37. The device of claim 36 wherein the third signal  
2 produced by the second Fourier transform module comprises  
3 real and imaginary components.

1 38. The device of claim 37 further comprising:  
2 an adding component communicatively coupled to the  
3 second Fourier transform module to receive the third  
4 signal, add the real and imaginary components of the third  
5 signal and produce a fifth signal.

1 39. The device of claim 38 further comprising:  
2 a peak detector to detect the peak of the fifth  
3 signal and determine the time-shift required to align the  
4 received signal.

1 40. The device of claim 39 further comprising:

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2 a controller communicatively coupled to the peak  
3 detector to received the received signal according to the  
4 time-shift indicated by the fifth signal.

1 41. A system for aligning a received signal comprising:  
2 means for windowing the received signal to produce a  
3 symbol sample;  
4 means for multiplying the symbol sample and a  
5 reference synchronization symbol in the frequency domain  
6 to produce a first signal;  
7 means for determining the sign of the first signal to  
8 produce a second signal; and  
9 means for performing a Fourier transform on the  
10 second signal to produce a third signal containing time-  
11 shift information to align the received signal.

1 42. The system of claim 41 wherein the length of the  
2 symbol sample is equal to the length of the reference  
3 synchronization symbol.

1 43. The system of claim 42 wherein the windowing is  
2 accomplished by a Hanning windowing function.

1 44. The system of claim 41 further comprising:  
2 means for performing a Fourier transform on the  
3 symbol sample to transform the symbol sample from the time  
4 domain to the frequency domain before it is multiplied  
5 with the reference synchronization symbol.

1 45. The system of claim 41 further comprising:



